

DOCUMENTATION FOR AIRPORT UTILIZATION METRICS

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The following document provides details of National Airspace System (NAS) performance measures that were developed by MITRE's Center for Advanced Aviation System Development (CAASD), a Federally Funded Research and Development Center (CAASD). This work has been conducted under the sponsorship and direction of the Federal Aviation Administration (FAA) Air Traffic control System Command Center (ATCSCC)

Background

A set of Airport Utilization metrics have been developed for the purpose of measuring performance of the National Airspace System (NAS) on a next day basis. The aspect of performance being measured is how well an airport's arrival and departure capacity are used whenever there is demand to be met. The purpose of these metrics is to identify where performance for the previous day was either exceptional or less than optimal. This helps pinpoint where further analysis could be done in order to identify the contributing factors for that performance.

Airport Arrival and Departure Utilization are assessed for each 15-minute time period in the day.

Arrival Utilization—Assesses how well the Arrival Demand was satisfied for a given time period, taking into account the airport's target arrival capacity in that time period.

Departure Utilization—Assesses how well the Departure Demand was satisfied for a given time period, taking into account the airport's target departure capacity in that time period.

The utilization measurements can be combined to summarize the overall daily performance.

Arrival Performance—Assesses how well the Arrival Demand was satisfied in all time periods, taking into account the airport's target arrival capacity as it varied during the day.

Departure Performance—Assesses how well the Departure Demand was satisfied in all time periods, taking into account the airport's target departure capacity as it varied during the day.

Airport Performance—Assessment of the use of the airport's capacity, taking into account the relative importance of meeting Arrival and Departure Demand in each time period.

Arrival Utilization

Arrival Utilization compares what an airport did to what it could have done. Arrival Utilization scores will be 100 percent when either:

- The target arrival rate is met or
- All the demand is met (regardless of target)

Since both demand and capacity may vary over time, the day is divided into 15 minute time periods and the metric is calculated for each time period. Arrival utilization for a time period is determined by comparing the actual arrivals to the target AAR, or the demand, whichever is less.

$$\text{ArrivalUtilization}_t = \text{Arrivals}_t / \min(\text{ArrivalDemand}_t, \text{ArrivalRate}_t)$$

An example for Arrival Utilization is provided in Figure 1 in which the three components for measuring it (Demand, Actual Arrival, Arrival Rate) are shown in 15 minute intervals.

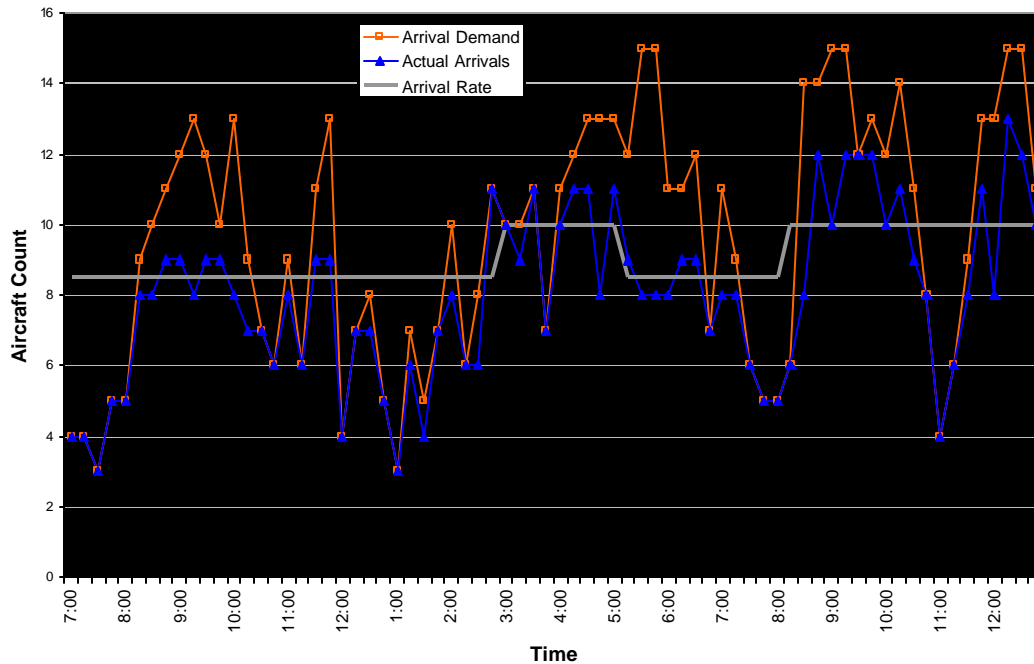


Figure 1. Example Arrival Utilization over Time

$Arrivals_t$ is defined as the number of aircraft that land during a specified time period. Enhanced Traffic Management System (ETMS) data are used to calculate the number of actual arrivals. The landing time is the airline-supplied “on” time, if available, otherwise the landing time is determined from the ETMS arrival (AZ) message.

$Arrival_Demand_t$ is defined as the number of aircraft that could land within that time period. For the purposes of this calculation an aircraft is presumed to be capable of landing starting at the estimated time of arrival (ETA) specified in its ETMS departure (DZ) message, or at its actual arrival time, whichever is earlier. That is, an aircraft’s Arrival Demand period lasts from its ETA to its arrival time, except if the ETA is later than the arrival time then the demand period coincides with the arrival time.

The AAR/ADRs are supplied from FAA facilities. It is possible for the number of arrivals to exceed the target rate, in which case the arrival performance will be more than 100 percent. Although performance may exceed 100 percent, when the utilization score is computed, the score is taken as the minimum of the performance and 100 percent.

An aircraft may contribute to Arrival Demand during more than one time period. If the ETA is 20:10 and the aircraft actually lands at 20:35, the aircraft adds one to the demand count in each of three time periods: 20:00-20:14, 20:15-20:29 and 20:30-20:44. This definition of demand means that demand is always greater than or equal to the actual number of aircraft that land. Note that the demand is solely generated by aircraft that have actually departed, not those that have only filed flight plans.

Each arrival utilization score can be combined in order to provide an overall daily arrival score. The formula used to do so is provided below.

$$\text{Arrival Score} = \sum_t [\text{ArrivalUtilization}_t * \text{ArrivalDemand}_t] / \sum_t (\text{ArrivalDemand}_t)$$

Departure Utilization

The computation for Departure Utilization is similar to that of Arrival Utilization and is defined as:

$$\text{Departure Utilization}_t = \text{Departures}_t / \min(\text{Departure Demand}_t, \text{Departure Rate}_t)$$

Departure Demand_t is defined as the number of aircraft that “want to depart” in that time period. If a flight has an Estimated Departure Clearance Time (EDCT), the EDCT defines the start of the demand period. Otherwise, the start of a flight’s departure time demand period is estimated as the airline-supplied pushback (“out”) time plus an airport-dependent unimpeded taxi time. If the “out” time is not available, the proposed time (PTIME) from the Flight Plan (FZ) message plus an airport-dependent unimpeded taxi-out time is used as the start of the Departure Demand period. Finally, if the PTIME is not available, or it is subsequent to the actual departure time, the demand period is assumed to be coincident with the actual departure time. When available, the airline-supplied “off” time is used as the actual departure time, otherwise the actual departure time is taken to be the time in the (DZ) message

Again, individual utilization scores can be combined in order to provide an overall daily departure score. The formula used to do so is provided below.

$$\text{Departure Score} = \sum_t [\text{Departure Utilization}_t * \text{Departure Demand}_t] / \sum_t (\text{Departure Demand}_t)$$

Airport Performance

Both arrival and departure measures are combined to give an overall indicator of airport performance in the time period. At some airports there is an explicit tradeoff between accommodating arrivals and departures. The airport performance metric recognizes the need to give priority to arrivals during arrival pushes and departures during departure pushes. In the present formulation, the airport performance score is weighted according to the relative amount of Arrival Demand as compared to Departure Demand.

$$\text{Airport Performance}_t = \text{Arrival Importance}_t * \min(100 \text{ percent}, \text{Arrival Utilization}_t) + \\ \text{Departure Importance}_t * \min(100 \text{ percent}, \text{Departure Utilization}_t)$$

The relative importance, or weighting, of meeting Arrival Demand, as opposed to Departure Demand, in time period t , is calculated as:

$$\text{Arrival Importance}_t = \text{Arrival Demand}_t / (\text{Arrival Demand}_t + \text{Departure Demand}_t)$$

Similarly,

$$\text{Departure Importance}_t = \text{Departure Demand}_t / (\text{Arrival Demand}_t + \text{Departure Demand}_t).$$

Note that $\text{Arrival Importance}_t + \text{Departure Importance}_t = 1$. Therefore, airport performance always lies between arrival performance and departure performance.

The airport performance score is calculated by weighting the time periods according to percentage of total demand.

$$\text{Airport Performance} = \frac{\sum_t [\text{Airport Performance}_t * (\text{Arrival Demand}_t + \text{Departure Demand}_t)]}{\sum_t (\text{Arrival Demand}_t + \text{Departure Demand}_t)}$$

This weighting scheme has the effect of placing the most emphasis on performance in time periods when demand is high, so that meeting the target rate in those time periods is essential for a high performance score.